NOVEL PROBE-TYPE OXYGEN SENSOR TO MEASURE OXYGEN CONSUMPTION IN BEEF STEAKS

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I. OBJECTIVES

Oxygen consumption (OC) is an inherent muscle property that influences beef color. More specifically, greater OC results in less bloom and darker meat color, whereas lower OC can promote a bright-red color. Mitochondrial function, microorganisms, and oxidative processes can influence oxygen utilization. Hence, the quantification of OC is important to characterize beef color changes. The OC measured using reflectance approach indirectly measure oxygen utilization based on changes in myoglobin redox forms. Here, we discuss a novel fiber optics oxygen probe to measure changes in percentage partial pressure oxygen on the surface of beef *longissimus lumborum* steaks. Therefore, the objective of the current study was to compare OC using near infrared (NIR)-based oxygen sensor, fiber optics oxygen probe, and reflectance approach.

II. MATERIALS AND METHODS

Steaks from 4 beef *longissimus lumborum* Choice loins were used in the study ($n = 4$; postmortem age > 7 d). The OC quantification using the reflectance method was based on the American Meat Science Association Color Guide. In brief, steaks were bloomed for 1 h and then vacuum packaged and incubated at 30°C for 30 min inducing conversion of oxymyoglobin to deoxymyoglobin. The color changes were measured using a HunterLab MiniScan spectrophotometer, and oxymyoglobin level was calculated as [1 − (K/S610 ÷ K/S525)]. K/S represents the absorption and scattering coefficient determined at 610 and 525 nm. For NIR-based approach, the methodology used in reflectance OC was followed, and a Peripedal MOXY-3 Muscle Oxygen Monitor was used to measure the amount of oxygen on bloomed and deoxygenated muscle. Thirdly, an Ocean Optics Neo Fox Oxygen Sensing System probe was utilized to measure percent surface oxygen of steaks. Steaks were bloomed for 1 h and then packaged in plastic bags flushed and filled with nitrogen gas, then incubated at 30°C for 30 min allowing for conversion to deoxymyoglobin. Percent oxygen levels were measured using the probe after a 1-h bloom period and after 30-min incubation period. Both NIR- and fiber optics oxygen probe gave oxymyoglobin/oxygen partial pressure in percentage. However, the reflectance approach determined oxymyoglobin levels in K/S ratios. Therefore, the percentage of OC was measured by the differences between pre- and post-percent muscle oxygen divided by pre-incubation value × 100. The assays were replicated 4 times, and data were analyzed using the Univariate Proc of SAS (SAS Institute Inc., Cary, NC).

III. RESULTS

The results suggest that the fiber optics oxygen probe was very sensitive to OC (85.7%, standard deviation =6.3, and variance = 2.5) and detected a higher percentage of oxygen with the lowest variance level compared with NIR and reflectance method. NIR-based MOXY detected greater levels of OC (12.9%, standard deviation = 6.2, and variance =40.1) with more variance than with using the HunterLab spectrophotometer (7.3%, standard deviation = 2.9, and variance = 8.7). The Neo Fox Oxygen probe directly measures the oxygen partial pressure on the surface, hence a larger difference in oxygen level was noticed before and after incubation than indirect measurements using handheld spectrophotometers.

IV. CONCLUSION

The results suggest that the fiber optics oxygen probe-type approach is a viable method to determine the OC of steaks.

Keywords: beef, meat color, myoglobin, oxygen consumption, probe-type sensor